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THE EVOLUTION OF MIND.

BY E. D. COPE.

BEFORE entering on this subject we must consider the nature of mentality. Mental acts display a great range from simple to complex. An attempt is made to exhibit their relations in the following table:

- Class I. Perceptions (presentations).
- Class II. Ideas (representations).
    - Division A. Memory of Perceptions.
    - Division B. Affection (taste, emotion).
    - Division C. Imagination.
    - Division D. Ratiocination.
        - Method A. Conception (generalization).
            - 1st Grade.
            - 2d Grade.
            - 3d Grade, etc., etc.
        - Method B. Induction (inference).
            - 1st Grade.
            - 2d Grade.
            - 3d Grade, etc.
        - Method C. Deduction (predication).
    - Division E. Will.

The divisions of this table are not mutually exclusive. With regard to the methods of Ratiocination as above enumerated, it is to be noted that Induction and Deduction are distinct in kind from Conception, and are based on the latter, as well as on the simple Memory of Perceptions (Division A). While Conceptions are classifications, Induction and Deduction follow the Memory of Perceptions whether classified or simple. Will is expressed in action induced by any of the faculties embraced in the four preceding divisions.

In this chapter I will first compare the mental faculties of man and the animals below him, and will then consider their progressive evolution.

I. CONSCIOUSNESS.

The faculties of perception or observation, form the primary division of mental processes, and the most simple. They include those of general sensation and of special sensation. To the latter belong smell, hearing, taste, and sight; to the former, touch, temperature, muscular sense, etc. It may be inquired, What have these functions in common with the affections, the intelligence, and the will? They have the important characteristic in common, that they are all forms of consciousness, or self-knowledge. All of these functions are forms of consciousness, although some of the representative faculties may become automatic and unconscious after education. Consciousness, then, is the one common property of all mind; and, from the point of view of the evolutionist, progressive development of mind is the advance from the simpler to the more complex, or from the generalized to the specialized forms of consciousness. Mind, then, in this general sense, embraces every and all kinds of metaphysical condition, including the unconscious derivatives of conscious antecedents. Of this latter mental type more will be said later.

That many of the higher animals possess mental faculties which must be referred to the divisions of the intelligence and the affections, is evident to every person who is familiar with the animals themselves. That the simpler affections or " instincts " are present in animals very far down in the scale, is also obvious. That special senses exist in animals as low down as the Cœlenterata has been shown by Dr. Romanes and Prof. Eimer. General sensation is probably present in still lower forms of life; but which of them possess this simplest form of consciousness, and which do not, is at present very difficult to state. We may, however, form an estimate of probabilities in the case by observing the movements of Protozoa under stimuli, as well as those of the spermatozoöids and phagocytes, which have a free existence within the bodies of all but the lower forms of life.

The test of the presence of conciousness as the condition of the performance of an act is to be found in the nature of the act. Consciousness may be supposed to be necessary to the performance of an act which displays a definite relation to the satisfaction of some need of the animal; but such an act does not necessarily prove that consciousness is present at the moment of action. It is well known that designed acts may be performed by the higher animals which have been deprived of their nervous sensory centers. Thus many vertebrates respond to stimuli applied to the extremities of their peripheral nervous system after the removal of the brain ; such movements are entirely appropriate to the stimulus, being directed to the removal of the source of the irritation. The presence of consciousness (or sensation) cannot be predicated on movements of this kind. In fact, many kinds of movements of considerable complexity are unconsciously performed by man with uninjured sensory centers, in consequence of their subjection to the process of automatization, which is education, of the centers. By continued repetition a given movement may be learned, so that consciousness is not necessary to its performance, as for instance, knitting and reading aloud. Walking and other comparatively simple movements may be still more readily performed in unconsciousness. It is certain that even some of the higher functions of the brain, as classification, may be so performed. On account of these well-known phenomena it is supposed by a class of thinkers that consciousness has not been necessary to the original performance of any act, no matter how complex it may be, and no matter how evident the design. They suppose that action has been promiscuous or multifarious, and that natural selection has preserved those individuals whose movements chanced to be beneficial, and that those whose movements have been of a useless or injurious kind have been destroyed.

There are two objections to this explanation of the origin of designed movements. The first is, that in all cases where we have the opportunity of observing the origin and development of such acts, we find that they have to be learned, and that they only become automatic after a more or less prolonged period of education. This process of education is one that involves the presence of consciousness, or the experience of pleasures and pains, as consequences of movements. The movements are first performed under the experience of the necessity of securing the one, and of avoiding the other; a desire which is a condition of consciousness wherever it exists. Another objection to the explanation of the origin of designed acts by fortuity and natural selection, is identical in character with that which has been urged against the similar explanation of the origin of permanent variations of structure. The chance of the accidental performance of profitable movements among all possible movements, is very small; and the chance of the repetition of such movements by a sufficiently large number of individuals to cause them to be preserved by reproduction and inheritance is much smaller. In order to preserve such movements so that they should become habitual in a single individual, it would be necessary they they should be performed by it frequently,—a probability which diminishes directly in proportion to the frequency required to produce that result. Thus our negative knowledge of this subject agrees with our positive knowledge in impressing us with the extreme improbability of a single habitual designed act having arisen and been perpetuated by chance.

It is sometimes doubted whether consciousness can exist in such simple beings as the Protozoa. But this doubt seems to be unnecessary after a consideration of the organization of such higher forms of life as we know to be conscious. The higher multicellular animals, or Metazoa, consist of a colony of cells which display different degrees of specialization for the performance of the different functions to which evolution assigned them. Their degree of specialization is of course measured by their degree of departure from the simple, primitive nucleated cells from which they have been derived by descent. Perhaps the most specialized are those which have become the threads of the connective and elastic tissues, and those of the tendons. Those of the modified epithelial tissues which cover the integument of the body, with its appendages, as scales, nails, horns, and hairs, are also highly modified. Muscular tissue is a little less specialized. In none of these tissues do we find consciousness. It is not certain that sensation resides in any but the cells of the nervous system, and if those of the peripheral parts of the system possess it, they do not retain it if they lose their connection with the central system. Now the cells of this system are the least modified of all those that constitute the soma of the metazoon, and thus they resemble most nearly the simple beings which constitute the lowest forms of the Protozoa. If they are capable of sensation in the one case they are likely to do so in the other. It appears that the conscious cell is the primitive cell, and the unconscious cell is the modified or specialized cell. And this conclusion coincides with what we know of the relation of consciousness to function in the animals in which we can examine the history of both. Specialization of structure means specialization of function; and specialization of function means accomplished education. Completed education, as we have already seen, means unconsciousness, while consciousness is necessary to the beginnings of education, and to its successive steps up to completion. We are then led by the analogies of the education of tissues, as well as by their structure, to the belief in the presence of consciousness in the Protozoa. The demonstration of a sense analogous to sight in the Infusoria by Klebs and Pouchet, and in the Cœlenterata by Romanes and Eimer, renders it unnecessary to pursue the argument further into the next higher type of the animal kingdom.

Were the above reasons insufficient to lead us to our conclusion, a consideration of the movements of the Protozoa would do so. All authorities agree that some of the actions of the Infusoria are in no sense automatic, but display a design as appropriate to the occasion as do those of the highest animals. The movements of the body of these animals are definitely directed towards their food or prey, and towards their opposite sex, and as definitely directed away from dangerous enemies. The movements of particular parts of their bodies, as of their cilia and flagella, have definitely designed movements for special occasions. Some of the movements of the Amœbæ have been, probably correctly, regarded as having a purely physical origin, due to the mobility of their protoplasm, and their contractility; but others, such as the projection of pseudopodia towards food with which they are not already in contact, cannot be explained in this way. Their selection of food and rejection of injurious substances, though not always performed without errors, indicates the presence of sensation. The building of external protecting envelopes composed of grains of solid substances by the Difflugiæ cannot be explained by the action of physical causes only; and the arrangement of pieces in regular order as an envelope by the Rotifer Melicerta indicates still more definitely the presence of consciousness in some form.

We cannot discover any such design in the movements of phagocytes and of spermatozoöids. The former engulf leucocytes and other bodies with which they come in contact, very possibly for physical reasons, but do not pursue them, nor indicate their perception of their presence in any way. The movements of spermatozoöids appear to be without direction other than that given them by the vibrations of their flagella, by the cilia of the canals which they traverse, and perhaps by some physical attraction not at present explainable. The attraction of the spermatozoöids of certain ferns and hepaticæ by solutions of malic acid and cane sugar have been regarded as chemical, but this can scarcely be the correct explanation. A physical relation is much more probable, if sensation is excluded.

The presence of predication cannot be inferred from the existence of consciousness in the lowest forms of life. An action is designed if it is a response to a present stimulus or sensation, even if there be no memory, and the act is a new one every time the stimulus is applied. It is evident, however, that education commences low in the scale, since some of the acts of the Infusoria indicate an adaptation of means to ends which cannot be supposed to be possible to a totally new experience. The discharge of the weapon-like cilia of the Dinidium at its prey would indicate that the animal knew the effect of the act from past experience, and anticipated that food would be secured in this way from its success in previous performances of the kind. Memory is, so far as we know, a general attribute of living protoplasm, and it is probable that it enters into the psychic acts of very low organisms. It may be in the beginning unconscious memory,—merely the habit of identical response to identical stimuli, on the principle that energy in organic substances most easily traverses accustomed channels. But it is not easy to believe in a stimulus which is not consciously felt producing anything but an undesigned, indefinite movement; and memory, conscious or unconscious, could only repeat it. A movement directly related to the satisfaction of sensation could only originate in a sensation, and the unconscious memory would repeat it blindly on the occasion of the experience of an identical stimulus. So soon as conscious memory should appear, the possibility of more exact adaptation or design in an act would appear. Variations in the act appropriate to variations in the stimulus would become possible. We may suspect conscious memory in the exact ratio of the appearance of predication under slightly varied circumstances, when narrower resemblances and differences are evidently to be taken into account. In such cases comparisons of memories are necessary, and rudimentary classification begins.

Mr. Romanes, in his work, "Mental Evolution in Animals," gives the following as his "criterion of mind": "The criterion of mind, ejectively considered, consists in the exhibition of Choice, and the evidence of Choice we found to consist in the performance of adaptive action suited to meet circumstances which have not been of such frequent or invariable occurrence in the life-history of the race as to have been specially and antecedently provided for in the individual by the inherited structure of its nervous system." This is an excellent definition of mind which has reached the stage of predication. But for purposes of classification, I should include all the phenomena of consciousness in the domain of mind, as distinguished from that of no-mind or physical energy. Such is the custom of metaphysical writers, who include perception within the range of their science, as it seems to me properly. The simple sensations should be included within the realm of mind. Here also should be included the "subconscious" state, with which we are all more or less familiar. Thus an impression may be made on the mind while its principal consciousness is otherwise occupied, and this impression may lead to attention, which is followed by a more distinct impression, if the cause of it is still present. And the subconscious impression may be recorded as a memory, but not so thoroughly as if the impression were more distinct. Thus, the fleeting pictures of dreams are feebly impressed and but slightly recorded as memories. Such subconscious states may well be frequent in animals, especially in those where the external conditions are uniform, and new stimuli infrequent, for longer or shorter periods. But vigorous stimuli, as appeals to the general or special senses, quickly rouse animals, as well as man, to intense degrees of consciousness.

Since the sense-perceptions are well known to exist in animals, I will not give further special attention to them. Memory need not be especially considered, as its existence is necessary to the activity of all mental processes. I therefore proceed to the illustrations of the affections and the reason as observable in animals below man. Equally necessary to the existence of both affection and reason is association. Association of pleasures or pains with given objects forms the basis of liking and disliking, and of designed or rational action with regard to them. The more especial characters displayed by association will be especially treated of under the head of the reason or intelligence.

2. THE AFFECTIONS.

Preferences for especial articles of food and drink are known to characterize animals, not only on the ground of physiological necessity, but for reasons less easily explained. Reasoning from our own experience, we may ascribe the latter class of preferences to the gustatory sense, which is stimulated by certain flavors, and which rejects others. The gustatory sense, together with its near ally, the olfactory, is generally a safe guide to the function of assimilation, but not always, and in mankind it is often quite whimsical. In general, all of the "appetites" are common to man and the other animals.

More pronounced likes and dislikes are common among animals, and these are to be generally attributed to the action of association of memories, pleasant and unpleasant. The smell and sight of blood create the greatest excitement among animals of the ox kind, so much so that even the color red stimulates the antagonistic passions of the bull. The action of association is here evident. The dog associates the gun with the chase, and as soon as he sees his master take it up his passion for hunting his food is aroused, and his joy is demonstrative. Sudden movements near a hive of bees or a nest of hornets (*Vespa maculata*) are unsafe, as these insects evidently anticipate danger, and proceed at once to attack the supposed enemy. The emotion of fear of all degrees is well-nigh universal in the animal kingdom, as few species, from the Protozoa upwards, do not endeavor to escape a present or anticipated danger. In no animal is fear more strongly developed than in some of the monkeys. A *Cebus capucinus* and a *C. apella* in my possession sometimes escaped from their cage, and could only be caught after a vigorous chase. In pursuit they became so terrified as to fall in an unconscious condition on the floor. They were cold when picked up, but they soon recovered. I have never known any other species of animal to faint from fright.

The social affections are seen low in the scale, and the maternal instinct is the first to present itself to our notice in the order of development. The endeavors of females to protect their eggs may be due to the fact that they regard them as part of their own bodies, as in the case of spiders, but an altruistic feeling (in the selfish sense of the word) must be admitted to be present in the exercise of the care of the young. This affection appears sporadically among invertebrate animals, but is very general among Vertebrata, becoming a master passion in many of them. The attraction of the female for the male is seen in low forms of life, where it is transient, and often little or not at all reciprocated on the part of the female, so that contrivances for the compulsory fertilization of the latter by the former are numerous. In the higher forms the affection is more or less reciprocal, and in the highest forms a distinct conjugal affection is developed. Whether this exists in forms below the birds is uncertain. Rattlesnakes associate in pairs, as do also sword-fishes. An account is given by Brown Goode of a furious and successful assault on a boat made by a sword-fish whose mate had been harpooned and captured by the boat's crew. Mutual affection between two individuals of the same or of different species, without regard to sex, is not uncommon among birds and in mammals, and is probably an outgrowth of the maternal and sex instincts. The affection of many of the Mammalia for their human masters is well known, although this sentiment differs greatly in degree in individuals o fthe same species, as, for instance, in the dog.

Shame is evidently experienced by some of the Mammalia, especially by monkeys and by dogs. This affection is an anticipation of the ethical sense, a quality which will be considered under the head of the intelligence, further on.

Jealousy is strongly developed in Mammalia, especially among dogs. It is quite as obvious among these animals as among human beings. An illustration of jealousy on the part of a chimpanzee used frequently to amuse the visitors to the Zoological Garden of Philadelphia. It was the custom of the keeper to feed a pair of these animals together with bread and milk, using a spoon. One sat on each side of him with an arm placed about his waist, and the keeper fed them alternately. At times he would intentionally neglect one or the other of them. As this continued the neglected animal showed his displeasure by pouting the lips, and finally he would rush from the side of the keeper, and throwing himself on his back would give way to a burst of jealous rage. He kicked his feet, threw straw into the air, and screamed vigorously, the whole proceeding resembling what one sometimes sees in a spoiled child. On the offer of renewed attention from the keeper, the chimpanzee was pacified, and took his original position with great satisfaction.

Another and older chimpanzee confined in the same garden became paralyzed in the posterior limbs. Two lemurs (*L. catta.*) were given to it for company. Their playful activity was at times a source of irritation to the chimpanzee. Her grimaces and cries of rage at these harmless creatures were laughable, and her impotent attempts to dislodge them from their hold above her, by shaking the wood-work on which they rested, was an exhibition of passion which was quite ridiculous.

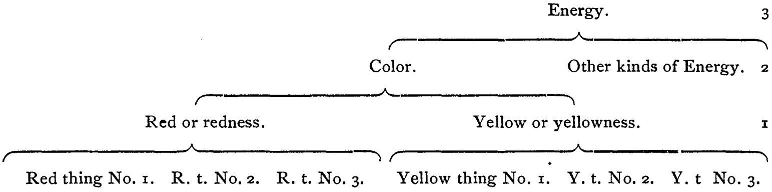
Admiration for brilliant or impressive colors or forms is evidently experienced by the vertebrate animals. It is probably present much lower in the scale. Protozoa collect about the light, and show a decided preference for certain colors. This attraction is of course of a low type of mentality, expressive of a simple form of consciousness, but it cannot certainly be ascribed to chemical or physical causes. In any case it acts through sensation. Insects are believed to be attracted by showy flowers. Among vertebrates, birds show the most evident admiration for bright colors. The bower-birds (Ptilonorhynchus, Chlamydera, etc.) collect brightly-colored objects and arrange them about their play-houses and nests. The attention which the females of many birds which have brilliantly-colored males give to their exhibitions of themselves by the latter, is well known. The attractions thus offered to the females give opportunity for the sexual selection of Darwin and Wallace, which has no doubt had much to do with the preservation of beauty and other admirable variations of animal type.

A most evident illustration of admiration for brilliant color and extraordinary form was furnished by the monkeys in the Zoological Garden of Cincinnati. A large adult male mandrill (*Cynocephalus mormon*) was confined in a large cage with numerous smaller species of the old world monkeys. The mandrill had reached the age when the crest, beard, and bright blue, vermilion, and purple colors of the skin were in perfection. The smaller monkeys displayed the most respectful admiration for the huge beast, who stood or sat in the middle of the cage and received their adulation. The smaller species gazed upon the wonderful harlequin and moved about him in a deferential manner. His majesty occasionally seized one of them by the tail or the hind leg, and after submitting him to an examination, flung him from him with an expression of contempt. This did not seem to check their devotions, however, and they continued moving about him in circles and gazing at him.

3. RATIOCINATION.

In this section I will endeavor to state the character of the mentality of animals with respect to the faculty of reason, and to compare the latter with the corresponding department of the mind of man. Considerable light as to the essential nature of reason must be gained from this research. It is well known that three distinct views may be taken of the source of this important faculty. These positions are the two extremes of realism and idealism, and the intermediate one maintained by Kant. According to Locke and the experiential school reason is a product of sense-perception or experience, and is *a posteriori*. According to Berkeley, Hegel, and the idealists, this faculty is *a priori* or intuitive, and creates the material world in its own likeness. Of this likeness sense-perception is the expression. According to Kant, sense-perception of a real universe is the material of thought, but it can only be comprehended through the necessary logical form of thought, which therefore presents a real material world to us in this form, but not as it is in itself. The relation which the evolution of mind has to this question will be considered in another essay.

Conception.—While perception and emotion are very generally granted to animals, it has been often denied that they are capable of conception or generalization. The formation of a concept is a result of classification, and the general idea which is a concept, is not an object, but a mental picture of several objects or parts of objects in combination. Concepts are of various grades of generality, as may be exhibited in the following table:



In the above analysis three grades of generalization are represented; all derived from the individual objects enumerated in the bottom line. Each one requires successively greater mental grasp, and in the case of the highest generalization, the especial knowledge attained only by the scientific man. But the first or lowest grade of generalization is clearly within the scope of the animal mind. Thus the bull attacks a red object without ascertaining especially whether it is blood or a red cloth; he sees only the redness. So with the water-fowl seeking water. He alights on a surface of water when and where convenient, without discrimination as to the particular piece of water. The crow and other animals avoid man in general, without discrimination as the particular man, in the absence of special instruction. That this is an exact generalization is shown by the usual indifference of such birds, etc., to cattle and other, to them, innocuous animals. In fact, it is quite easy to show, as Mr. Romanes has done, that a low grade of generalization is common to most animals, and that it is quite as natural to them as the particularization of individuals. That they are at the same time not incapable of particularization is easily seen. The water-bird ultimately seeks its accustomed locality for breeding. The bird or mammal learns to know its master, and to distinguish him from other persons by their confidence and friendship.

It is claimed by Professor Max Müller and other persons, that conception is impossible without language; *i.e.*, that it is impossible to form concepts without words to represent them as symbols. Now this is clearly not the case. The naturalist conceives his genera, orders, classes, etc., before he names them. One can readily conceive of redness, yellowness, etc., without naming them, and it is perfectly evident that many animals below man do the same.[1] It is only a question of the mental power of the individual as to how wide a generalization he can thus conceive.[2] I see no reason why this power may not extend to the highest possible grade of generalization in the most able of human minds. Nevertheless to most persons symbols or names are necessary to the accomplishment of the higher concepts. Names constitute an invaluable aid in the construction of rational edifices. They are well compared to a scaffolding to a building, and it is quite possible, as Romanes remarks, for a grade of conception thus attained to need the aid of words no longer, and to become automatic, and a part of the mental furniture. That the use of words has been the cause of an acceleration of rational development in man there can be no doubt; but the mentality of the lower animals contradicts the supposition that it was entirely essential.

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[1] This has been well shown by Mr. Romanes in his Mental Evolution of Man, Origin of Human Faculty, Chap. III.

[2] For this reason I do not see the necessity for the subtraction of the lowest grade of concepts under the name of " recepts," as has been proposed by Mr. Romanes, *l.c.* Chap. II. Other grades of generalization might be as readily separated under distinct names.

Many of the mammalia understand human language. They understand the meaning of words apart from tone and gesture. This can be most frequently seen in dogs, some of whom become remarkably expert in carrying out orders from their masters. Examples of this kind are familiar to many persons. Now the giving of orders involves the use of verbs. Verbs do not represent objects, nor do they represent even single acts, but they express a class of single acts. In the comprehension of a verb, a dog performs an act of simple generalization, distinctly above the mere recognition of an object by a name.

Induction.—Most evident is the existence in animals of the faculty of induction, which involves a generalization; *i.e.*, the drawing of a single general inference from a number of instances. While pure conception expresses cognition only, induction infers action on the part of its objects. From such and such premises, such and such events will follow, either as coincidence or as effect.

I now give some illustrations of experiential inference, and deductive or practical application, among the lower animals.

A great many animals adopt methods of concealment to escape observation, both of enemies and of the prey they seek. Certain species of crabs attach to their carapace pieces of algæ, which then vegetate and cover the animal with a growth which conceals it. Others carry a stone above the posterior part of the carapace, which serves as a basis of attachment for foreign organic growths which conceal them. Still others permit the growth of sponges and actiniæ on various portions of their surface, which sometimes cover them completely from view. Among birds peculiar attitudes are adopted, which serve as an effective concealment; such are those of some of the herons, which stand bolt upright in growths of reeds and thickets, so as not to be distinguished from the surrounding stems and trunks. So the

Gallinæ and some of the snipe family squat on ground, which they resemble in color, until danger has passed. An ingenious device is employed by certain green snakes of North America (*Liopeltis vernalis*). They burrow under the earth, and then permit the head and a few inches of the body to emerge. This portion of the body is held rigidly vertical, and is not distinguishable on a cursory view from the shoots and stems of green vegetation which surround it.

Fear sometimes stimulates an animal with the desire to inspire fear in return. I once observed this in the conduct of a *Heterodon platyrhinus* (hog-nose adder), which was kept in a cage with a water-snake (*Natrix sipedon*) and a copperhead (*Ancistrodon contortrix*). Both of the harmless species were evidently greatly frightened on the introduction of the copperhead into the cage. The water-snake sought the lowest spot in the sand on the bottom of the cage, and coiling up kept close to the ground, not even raising his head. The Heterodon, on the contrary, inflated his long lung, swelling the greater part of his body into the form of a cylindrical bladder. He at the same time extended the anterior ribs, so that this part of the body resembled the thin blade of a paper-cutter. He then plunged his nose into the sand, and covered the top of his head with as large a pile of that substance as it would carry. In this disfigured condition he paraded slowly about the cage in front of the copperhead. The latter moved but little, and showed no disposition to provoke a quarrel with its singular companion. The *Heterodon platyrhinus*, when disturbed by man, throws itself into vigorous contortions, spreads the anterior ribs, and opens the mouth widely, after the manner of a venomous snake. The habit of erecting, under the stimulus of fear, the feathers and hair in order to increase the apparent size of the body, and so inspire fear, is common among birds and mammalia. The artificial ferocity of many monkeys, while under the influence of the very opposite emotion, *i.e.*, fear, is often very amusing. Monkeys generally look away from a person whom they wish to attack, so as to throw the latter most completely off his guard.

(*To be continued.*)